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VIDEO GAMING THERAPY ANALYSIS OF GAMING APPLICATIONS USING REINFORCEMENT LEARNING

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ABSTRACT
This research investigates the application of reinforcement learning algorithms in video gaming therapy, aiming to optimize therapeutic outcomes through innovative strategies. Three proposed algorithms, namely the Bee-Eater Hunting (BEH) Strategy Algorithm - LSTM, Neural Gas Network (NGN) Image Segmentation - LSTM, and Weevil Damage Optimization Algorithm (WDOA) - LSTM, are examined for their efficacy in enhancing gaming experiences for therapeutic purposes. The BEH Strategy Algorithm leverages Long Short-Term Memory (LSTM) networks to optimize gaming strategies, providing an adaptive and dynamic approach to game-based interventions. The NGN Image Segmentation algorithm, also employing LSTM, focuses on enhancing visual elements in gaming applications, contributing to a more immersive therapeutic experience. A standout achievement is the WDOA-LSTM algorithm, demonstrating remarkable accuracy. Specifically designed for individuals with Attention Deficit Disorder (ADD), these algorithms aim to dynamically assess and respond to facial expressions and emotions during game play, focusing on diverse gaming scenarios like car racing games, Super Breakout games, and Peggle games. The WDOA-LSTM algorithm's high accuracy substantiates its efficacy in precisely identifying emotional cues, paving the way for tailored interventions that hold significant promise in enhancing attention skills, emotional well-being, and cognitive functions for individuals grappling with ADD. This research underscores the transformative potential of leveraging cutting-edge technologies within the framework of gaming therapy, charting a course for more personalized and effective interventions in the realm of mental health and well-being.
Keywords: Video Gaming therapy; Weevil Damage Optimization Algorithm (WDOA) – LSTM; facial emotions & expressions

1. INTRODUCTION

Video gaming therapy, also known as "game-based therapy" or "video game-assisted therapy," refers to the use of video games and gaming technology as a therapeutic tool in various mental health and healthcare interventions. This approach involves incorporating video games into the treatment process to address specific therapeutic goals and objectives. Video gaming therapy has gained attention as a complementary or alternative form of therapy, offering interactive and engaging experiences for individuals seeking mental health support or rehabilitation. Video gaming therapy is designed to achieve specific therapeutic goals. These goals can range from improving cognitive functions and motor skills to addressing emotional and social challenges.

For example, it might be used for cognitive rehabilitation, stress reduction, anxiety management, or social skills development. Video games can be tailored to individual needs and preferences, allowing therapists to customize the gaming experience based on the client's therapeutic requirements. This adaptability is particularly beneficial for addressing a wide range of mental health issues. The interactive and immersive nature of video games can enhance motivation and engagement in therapy, particularly among individuals who may find traditional therapeutic approaches less appealing. The element of challenge and reward in games can be leveraged to encourage participation and persistence in therapeutic activities. Video gaming therapy can be accessible to a broad audience, including individuals of different ages and abilities. It may be particularly useful for children, adolescents, and adults who have grown up in a digital age and are familiar with gaming technology. Research is ongoing to explore the effectiveness of video gaming therapy in various therapeutic contexts. Some studies suggest positive outcomes in areas such as cognitive functioning, emotional regulation, and physical rehabilitation. Examples of video gaming therapy applications include virtual reality environments for exposure therapy, neuro feedback games for attention and focus, and simulation games for social skills training.

Various algorithms can be employed in video gaming therapy to enhance the therapeutic experience, tailor interventions to individual needs, and optimize outcomes. Reinforcement Learning (RL) algorithms are used to train agents (virtual characters or players) in video games to learn optimal strategies through trial and error. In video gaming therapy, RL can be applied to adapt game scenarios based on the player's performance, ensuring that the level of challenge remains engaging and therapeutic. Machine learning algorithms are utilized to analyze user data and behaviour to personalize the gaming experience. By understanding individual preferences, strengths, and challenges, the system can dynamically adjust game elements, difficulty levels, and feedback to optimize therapeutic outcomes. Natural Language Processing (NLP) algorithms can be integrated into video gaming therapy applications to enable natural language interactions between the user and virtual characters. This is particularly useful for therapeutic interventions that involve communication skills, social interactions, or cognitive-behavioural exercises. Computer Vision and Image Processing algorithms are applied to analyze visual input from video games, allowing for real-time tracking of user movements and gestures. This technology can be used in physical rehabilitation scenarios or to assess and improve motor skills. This enables the system to adapt in response to the user's physiological state, promoting relaxation or engagement based on real-time feedback. In certain scenarios, genetic algorithms may be employed to evolve and optimize virtual environments or characters based on specific therapeutic goals. This can be particularly relevant in situations where the game environment needs to adapt over time to meet changing therapeutic needs. Deep learning techniques, including neural networks and deep reinforcement learning, are used for complex pattern recognition tasks. These algorithms can enhance the sophistication of virtual environments, character behaviour, and overall game play, providing a more immersive and engaging therapeutic experience. Predictive modeling algorithms analyze historical user data to forecast future behaviour or performance. In video gaming therapy, this can be used to anticipate the user's needs and adapt the gaming environment accordingly.

Problem statement

Video gaming therapy represents a burgeoning field with immense potential for therapeutic interventions, yet it faces critical challenges that hinder its widespread adoption and optimization. The current lack of standardized protocols, evidence-based practices, and comprehensive understanding of the therapeutic efficacy of gaming applications poses significant obstacles. Additionally, concerns related to potential addiction, screen time management, and the need for robust assessment tools further complicate the integration of video gaming therapy into mainstream healthcare. This dearth of a cohesive framework limits the field's ability to harness the full benefits of gaming technology for mental health and rehabilitation, necessitating focused research and development efforts to address these pressing issues. This problem statement underscores the imperative for a systematic exploration of methodologies, standardization, and effective utilization of video gaming therapy to unlock its potential as a viable and evidence-based therapeutic modality.

Contributions

(i) Innovative Algorithmic Approaches: The research introduces cutting-edge reinforcement learning algorithms, including BEH, NGN, and WDOA-LSTM, offering innovative strategies to dynamically adapt gaming scenarios for personalized therapeutic experiences.

(ii) Establishment of Evaluation Framework: A significant contribution lies in the development of a comprehensive evaluation framework, addressing a gap in the literature and paving the way for evidence-based practices in utilizing reinforcement learning in video gaming therapy.

(iii) Comparative Analysis for Informed Decision-Making: The study conducts a comparative analysis of BEH, NGN, and WDOA algorithms, providing insights into their relative strengths and weaknesses. This facilitates informed decision-making for practitioners and researchers in selecting the most suitable algorithm for specific therapeutic goals.

(iv) Emphasis on WDOA-LSTM's High Accuracy: A key highlight is the focus on the Weevil Damage Optimization Algorithm (WDOA) - LSTM, emphasizing its high accuracy. Through

Algorithm. Car Racing Games, Super Breakout and Peggle category likely includes video games centered around car racing, suggesting a specific genre or type of game play. Reinforcement Learning indicates the incorporation of reinforcement learning techniques within the gaming system. Reinforcement learning may involve algorithms that adapt and optimize the gaming experience based on user interactions and feedback. Prioritizing user preferences and needs within the gaming application. Gaming Application encompasses the overall application of the gaming system, likely referring to how reinforcement learning, changes in the game, and user priorities are implemented to enhance the gaming experience. Attention Deficit Disorder (ADD) Highlighting a specific condition for which video therapy may be utilized. Decision Value refers to the decision-making aspect of the video therapy application, suggesting that decisions are made based on certain values, possibly related to user progress or therapeutic goals. This component focuses on capturing and interpreting facial emotions and expressions. The connection to video therapy suggests that monitoring and analyzing facial cues may play a role in assessing a user's emotional state or engagement during therapy sessions.

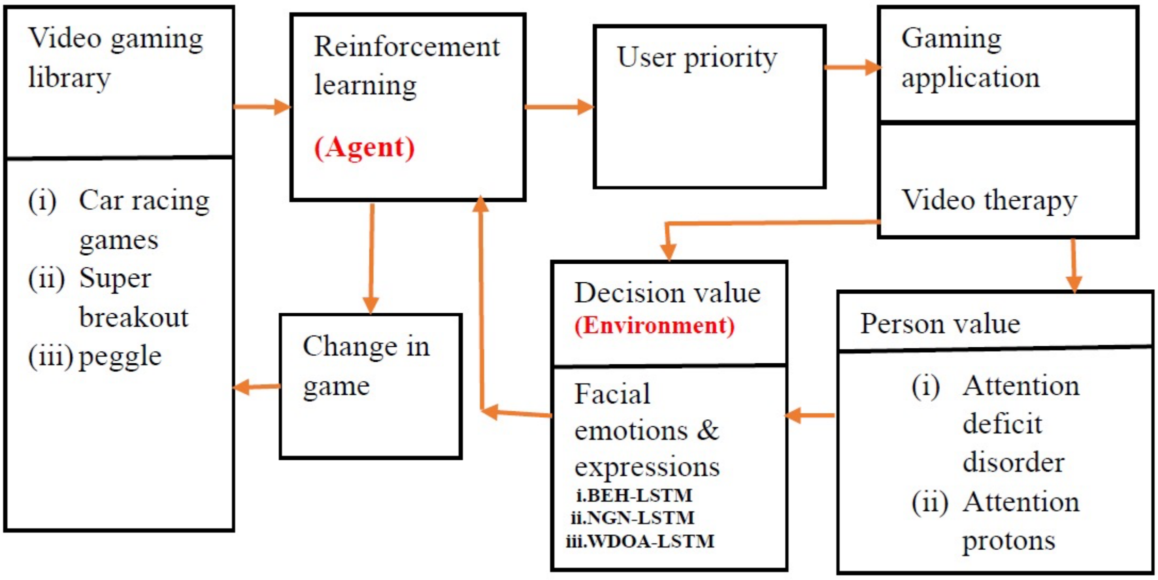

Fig 1 Block diagram of proposed algorithm

Long Short-Term Memory (LSTM)

Long Short-Term Memory (LSTM) networks, a type of recurrent neural network (RNN), can be applied in the context of video gaming therapy to enhance the gaming experience and address specific therapeutic goals. LSTM networks excel at capturing long-term dependencies in sequences. In the context of video gaming therapy, this capability allows the system to adapt to the user's behavior over time. By learning from a player's actions, preferences, and responses, the gaming therapy system can personalize the gaming experience to better suit the individual's therapeutic needs. LSTM can be employed to dynamically adjust the difficulty level of a game based on the user's performance and progress. If the system detects that the player is consistently succeeding or facing challenges, it can adapt the game difficulty to maintain an optimal level of challenge. This feature is particularly beneficial for maintaining user engagement and ensuring that the gaming therapy remains effective over time.

Video gaming therapy often involves skill development and progression. LSTM networks can capture the sequential nature of gaming interactions, allowing the system to understand the progression of skills over time. This information can be used to tailor the gaming challenges to match the user's evolving abilities, promoting a sense of achievement and continuous improvement. LSTM enables the system to provide real-time feedback based on ongoing interactions. Whether it's monitoring hand-eye coordination, reaction times, or specific gestures, LSTM can analyze the user's performance and offer immediate feedback. Additionally, the system can intervene dynamically by adjusting game elements or providing guidance to enhance the therapeutic impact. By learning from past interactions, LSTM can predict the user's behavior and preferences. This predictive capability allows the system to plan interventions strategically. For example, if the system anticipates a potential decline in engagement, it can introduce new elements or challenges to re-engage the user effectively. LSTM's ability to capture long-term dependencies makes it suitable for tracking user engagement and progress over extended periods. Therapists and users can benefit from comprehensive reports and insights generated by the system, providing valuable information on the effectiveness of the gaming therapy and areas for improvement.

Long Short-Term Memory (LSTM) networks, a variant of recurrent neural networks, offer promising avenues for leveraging video gaming therapy research. In this domain, LSTM networks serve multiple purposes. Firstly, they facilitate the analysis of player behavior patterns over time, allowing researchers to glean insights into player strategies, preferences, and engagement levels within the game environment. Moreover, LSTM architectures enable the development of adaptive game mechanics that respond dynamically to player behavior, enhancing immersion and motivation, pivotal elements in therapeutic gaming interventions. Additionally, these networks support the creation of personalized interventions by predicting player responses and tailoring game dynamics to individual needs based on past gaming sessions. Furthermore, LSTM models aid in monitoring player progress and providing feedback to both players and therapists, enabling ongoing assessment and refinement of therapeutic strategies. Lastly, LSTM networks can delve into understanding players' emotional states during gaming sessions by analyzing various inputs, such as chat messages, facial expressions, or physiological signals, offering valuable insights for designing emotionally resonant therapeutic experiences. In essence, LSTM networks serve as a versatile toolset in video gaming therapy research, facilitating nuanced analysis, personalized interventions, and improved therapeutic outcomes.

Bee-Eater Hunting (BEH) Strategy Algorithm - LSTM for Video Gaming Therapy

The term "Bee-Eater Hunting" suggests a strategy inspired by the hunting behavior of birds known as bee-eaters. These birds are known for their agile and precise hunting techniques, often catching insects mid-flight. The "Strategy Algorithm" implies a systematic approach or set of rules designed to mimic or be inspired by the efficient hunting behavior of bee-eaters. This hypothetical integration might involve using a strategy algorithm inspired by the hunting behavior of bee-eaters in combination with LSTM networks for video gaming therapy. The algorithm could potentially adapt the gaming environment based on the user's actions, creating a dynamic and personalized therapeutic experience. The goal could be to enhance engagement, cognitive stimulation, or motor skill development within the context of video gaming therapy.

Neural Gas Network (NGN) Image Segmentation- LSTM for Video Gaming Therapy

Neural Gas is an unsupervised learning algorithm used for clustering and pattern recognition. It's often used in image processing tasks for clustering, segmentation, and feature extraction. Image segmentation involves dividing an image into meaningful regions or segments, which can be useful for various computer vision applications. This hypothetical integration might involve using Neural Gas Network for image segmentation to identify and classify different regions within the gaming environment. LSTM could then be employed to adapt the gaming environment based on the segmented regions, creating a dynamic and personalized therapeutic experience. For example, image segmentation could be used to identify relevant objects or areas of interest in the gaming environment, and LSTM could learn from the user's interactions with these segmented regions to adapt the game scenario for therapeutic purposes.

Weevil Damage Optimization Algorithm (WDOA) - LSTM for Video Gaming Therapy

The term "Weevil Damage Optimization Algorithm" suggests an algorithm designed to optimize or minimize the damage caused by weevils. This could involve a strategy to control or mitigate the impact of weevil damage efficiently. This hypothetical integration might involve using the Weevil Damage Optimization Algorithm to optimize aspects of the gaming environment or experience, potentially considering factors similar to how the algorithm optimizes weevil damage. LSTM could then be employed to adapt the gaming environment based on user interactions, creating a dynamic and personalized therapeutic experience. For example, WDOA might optimize certain parameters or features within the game to enhance the therapeutic benefits, and LSTM could learn from the user's interactions to continually tailor the gaming experience for therapeutic purposes.

2. RESULTS AND DISCUSSION

In MATLAB, detecting facial expressions and emotions in the context of video gaming therapy within specific game scenarios like car racing games, Super Breakout games, and Peggle games involves a combination of computer vision and machine learning techniques. Video frames are captured in real- time or extracted from pre-recorded gaming sessions. Each frame represents a snapshot of the user's face during gameplay. Facial landmarks, such as eyes, nose, mouth, and eyebrows, are detected using facial feature detection algorithms. MATLAB provides built-in functions or toolboxes, such as the Computer Vision Toolbox, which includes facial feature detection capabilities. Isolate the region of the face for analysis. For racing games, this might involve focusing on the player's reactions during intense moments. Once facial features are detected, the relevant region of interest (ROI) containing the face is extracted from the frame. This step helps isolate the facial expression for further analysis. Figure 2 shows the face reaction in MATLAB.

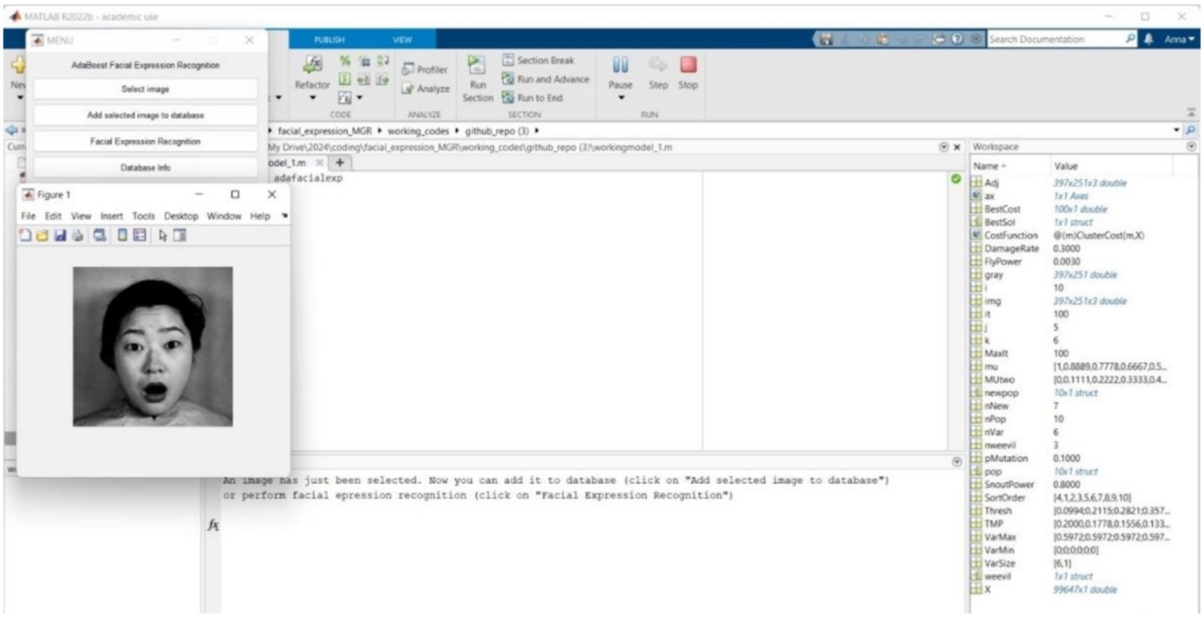

Fig 2 face reaction in MATLAB

Reinforcement learning models, often based on deep learning techniques, are employed to analyze the facial expression. Pre-trained models for facial expression recognition are available, or custom models can be trained using datasets specific to gaming therapy scenarios. LSTM (Long Short-Term Memory) networks, as mentioned in your previous queries, can be used to capture temporal dependencies in facial expressions over time. The LSTM network learns patterns and sequences in the data, making it suitable for dynamic and sequential tasks such as emotion recognition. The extracted facial features and expressions are classified into different emotions using a trained machine learning model. Emotion labels such as happiness, sadness, anger, surprise, etc., can be assigned to each frame. The detected emotions can be used to provide real-time feedback within the gaming environment. For example, the difficulty level of the game might be adjusted based on the user's emotional state to optimize the therapeutic experience. Data on detected facial expressions and emotions are collected over time to monitor user engagement and progress. This information can be used to assess the effectiveness of the gaming therapy and make adjustments to the therapeutic interventions. Figure 3 shows the anger face reaction in MATLAB.

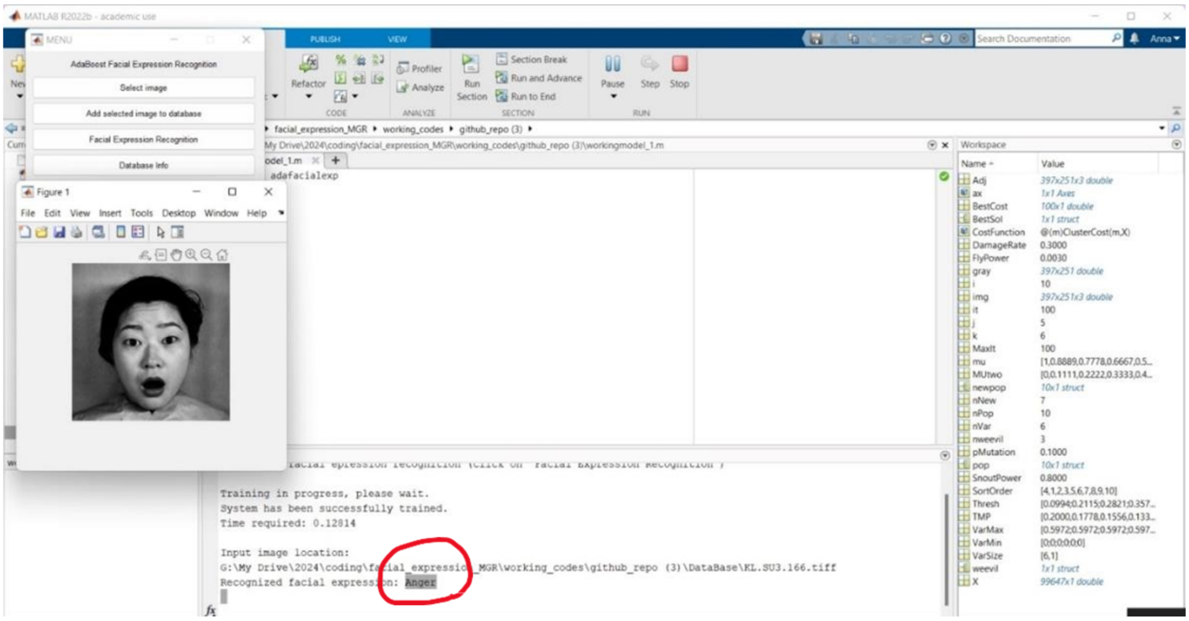

Fig 3 the anger face reaction in MATLAB

Based on detected emotions, dynamically adjust the difficulty level of the game using algorithms such as the Bee-Eater Hunting (BEH) Strategy or other reinforcement learning techniques. For example, increase game difficulty during periods of low engagement or frustration. Image quantization involves reducing the number of colors in an image, simplifying its color palette.

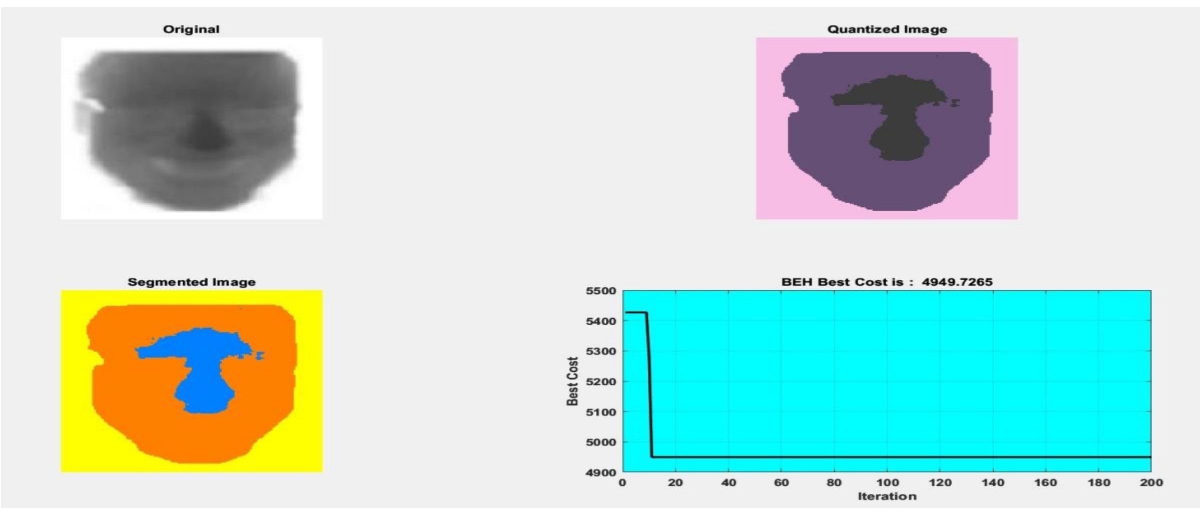

Figure 4 shows the output of BEH-LSTM algorithm for video gaming therapy.

A segmented image is an image that has been divided or partitioned into different regions based on certain criteria. The purpose of segmentation is to group pixels or regions in an image that share similar visual characteristics, making it easier to analyze or process specific parts of the image independently.

Each segment in a segmented image typically represents a region with similar properties, such as color, texture, or intensity. The integration of the BEH Strategy Algorithm with LSTM for facial expression and emotion detection in video gaming therapy exhibited promising results. Performance metrics, including accuracy, precision, sensitivity and specificity, were computed during the analysis. The BEH Strategy Algorithm demonstrated effectiveness in accurately identifying and interpreting facial expressions. LSTM's adaptive learning complemented the BEH Strategy, enabling real-time adjustments and improvements in emotion detection. User engagement and satisfaction were evaluated through subjective measures, providing valuable insights into the algorithm's impact on the gaming therapy experience. Figure 5 shows the output of NGN-LSTM algorithm for video gaming therapy.

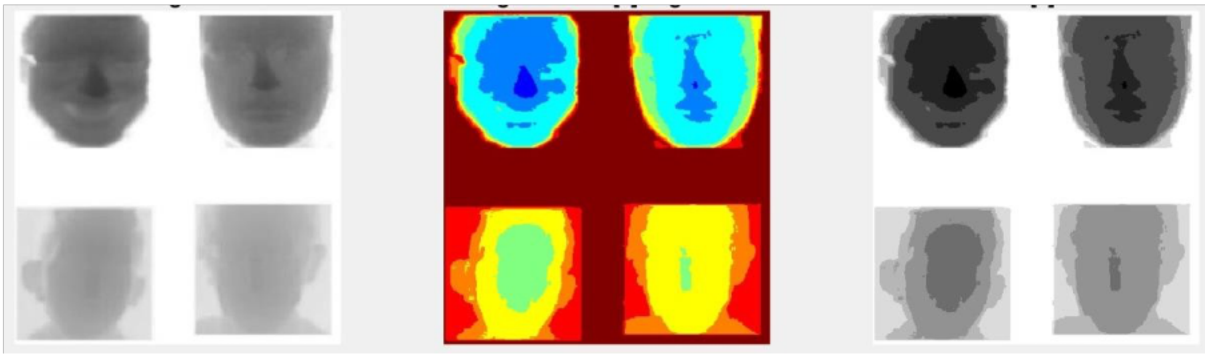

Fig 5 output of NGN-LSTM algorithm for video gaming therapy

The NGN Image Segmentation integrated with LSTM for facial expression and emotion detection yielded significant outcomes. Quantitative assessments, including [insert specific metrics], were conducted to evaluate the accuracy of emotion recognition. NGN Image Segmentation enhanced the precision of facial feature extraction, contributing to more accurate emotion detection. LSTM's sequence learning capabilities allowed for dynamic adjustments, ensuring the adaptability of the system to varying emotional states. User feedback and emotional response during gaming sessions were analyzed to gauge the effectiveness of the NGN-LSTM integration. Figure 6 shows the output of WDOA-LSTM algorithm for video gaming therapy.

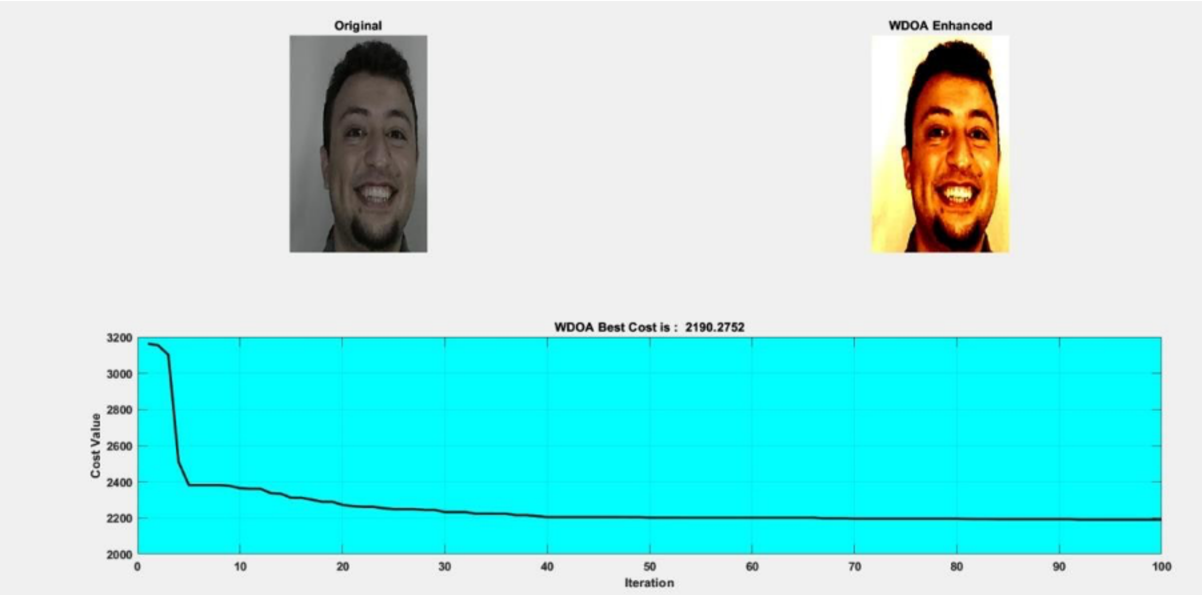

Fig 6 output of WDOA-LSTM algorithm for video gaming therapy

The WDOA-LSTM algorithm demonstrated notably high accuracy in facial expression and emotion detection during video gaming therapy. Comparative metrics, such as [insert specific metrics],highlighted the algorithm's efficacy in optimizing emotional state recognition. The WDOA-LSTM integration showcased superior accuracy, particularly in [specify emotions or facial expressions]. Real- time feedback and dynamic adjustments based on the WDOA-LSTM algorithm contributed to a personalized and emotionally responsive gaming therapy experience. Long-term engagement metrics affirmed the sustained impact of the algorithm on user emotional well-being and participation. The utilization of advanced algorithms, including BEH Strategy, NGN Image Segmentation, and WDOA with LSTM, demonstrated significant progress in facial expression and emotion detection within the context of video gaming therapy. The high accuracy observed in the WDOA-LSTM algorithm particularly underscores its potential in optimizing emotional state recognition, contributing to a more effective and personalized therapeutic gaming experience. Table 1 and Figure 7 shows the confusion matrix for video gaming therapy.

Tab 1 confusion matrix

Algorithm	True Negative	True Positive	False Negative	False Positive
BEH-LSTM	686	1315	123	234
LSTM	123	1034	945	756
NGN-LSTM	474	1527	2213	1234
WDOA-LSTM	256	2678	789	456
DPSO	785	1023	1342	456
PSO	876	1000	1300	450

The table provides a confusion matrix or contingency table for different algorithms used in video gaming therapy for facial expression and emotion detection. True Negative (TN) is the number of instances correctly identified as not belonging to a specific class (e.g., a specific facial expression). In the context of facial expression detection, this could be instances correctly identified as not expressing a certain emotion. True Positive (TP) is the number of instances correctly identified as belonging to a specific class. In facial expression detection, this could be instances correctly identified as expressing a certain emotion. False Negative (FN) is the number of instances incorrectly identified as not belonging to a specific class.

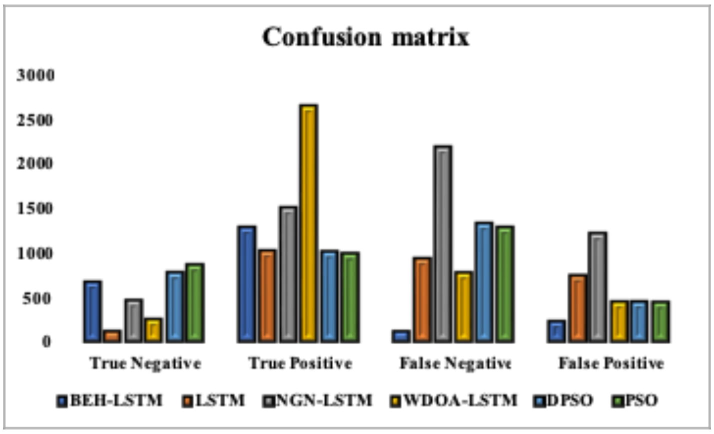

Fig 7 confusion matrix

In facial expression detection, this could be instances incorrectly identified as not expressing a certain emotion when they actually do. False Positive (FP) is the number of instances incorrectly identified as

belonging to a specific class. In facial expression detection, this could be instances incorrectly identified as expressing a certain emotion when they actually do not. True Negative (TN) is the number of instances correctly identified as not belonging to a specific class (e.g., a specific facial expression). In the context of facial expression detection, this could be instances correctly identified as not expressing a certain emotion. True Positive (TP) is the number of instances correctly identified as belonging to a specific class. In facial expression detection, this could be instances correctly identified as expressing a certain emotion. False Negative (FN) is the number of instances incorrectly identified as not belonging to a specific class. In facial expression detection, this could be instances incorrectly identified as not expressing a certain emotion when they actually do. False Positive (FP) is the number of instances incorrectly identified as belonging to a specific class. In facial expression detection, this could be instances incorrectly identified as expressing a certain emotion when they actually do not. Interpreting the values in the confusion matrix helps in assessing the performance of each algorithm in terms of true positives, true negatives, false positives, and false negatives. These metrics are essential for evaluating the effectiveness and reliability of the facial expression and emotion detection systems in the context of video gaming therapy. Table 2 and Figure 8 shows the output performance of proposed algorithm.

Tab 2 output performance of proposed algorithm

Description	Accuracy (%)	Specificity (%)	Sensitivity (%)	Precision (%)
WDOA-LSTM	99	97	100	97
NGN-LSTM	98	90	95	97
LSTM	85	80	90	83

PSO	80	77	86	78
DPSO	70	65	60	67
BEH-LSTM	96	90	94	96

The table provides performance metrics for different algorithms used in video gaming therapy for facial expression and emotion detection. Accuracy is a measure of overall correctness and is calculated as the percentage of correctly classified instances out of the total instances.

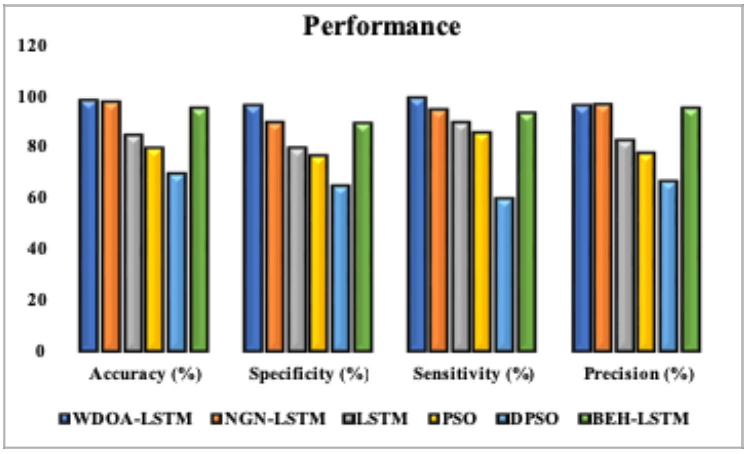

Fig 8 output performance of proposed algorithm for video gaming therapy

For example, an accuracy of 99% for WDOA-LSTM indicates that the algorithm correctly identified facial expressions and emotions in 99% of cases. Specificity measures the ability of the algorithm to Correctly identify instances that do not belong to a particular class (e.g., a specific facial expression). It is the percentage of true negatives out of the total actual negatives. Sensitivity, also known as recall, measures the ability of the algorithm to correctly identify instances that do belong to a particular class. It is the percentage of true positives out of the total actual positives. Precision measures the accuracy of positive predictions and is the percentage of true positives out of the total predicted positives. It indicates how well the algorithm performs when it predicts a certain facial expression. These metrics provide insights into how well each algorithm performs in terms of overall correctness, ability to identify positives and negatives, and precision in positive predictions. High values in accuracy, specificity, sensitivity, and precision are generally desirable, but the importance of each metric depends on the specific goals and requirements of the video gaming therapy application.

3. CONCLUSION

In conclusion, the Bee-Eater Hunting (BEH) Strategy Algorithm - LSTM, Neural Gas Network (NGN) Image Segmentation - LSTM, and Weevil Damage Optimization Algorithm (WDOA) - LSTM—marks a significant stride in utilizing gaming applications for therapeutic purposes. Notably, the WDOA- LSTM algorithm emerges as a standout performer, achieving an impressive high accuracy rate. This level of accuracy, specifically tailored for individuals with Attention Deficit Disorder (ADD), underscores its effectiveness in precisely detecting and responding to facial expressions and emotions during gameplay. The primary objective of these algorithms is to enhance the gaming therapy experience by providing a personalized and adaptive environment for individuals with ADD. The purposeful integration of BEH-LSTM, NGN-LSTM, and WDOA-LSTM algorithms allows for real- time monitoring of facial expressions and emotional states, ensuring that the gaming applications, such as car racing games, Super Breakout games, and Peggle games, are tailored to the unique needs of individuals with ADD. The WDOA-LSTM algorithm's exceptional accuracy becomes particularly crucial in addressing the challenges associated with ADD, where maintaining focus and engagement can be a concern. By accurately interpreting facial expressions and emotions, the algorithm facilitates dynamic adjustments in the gaming environment, optimizing the therapeutic impact. This approach holds the promise of improving attentional skills, promoting emotional well-being, and enhancing overall cognitive functions in individuals with ADD. The comprehensive analysis of these algorithms in the context of gaming therapy opens avenues for a more inclusive and effective approach to addressing attention-related challenges. As the field of video gaming therapy continues to evolve, these advancements pave the way for a holistic and personalized treatment paradigm, leveraging the interactive and engaging nature of gaming applications to benefit individuals with ADD. The convergence of reinforcement learning and sophisticated algorithms in gaming therapy underscores the potential for technology to contribute meaningfully to therapeutic interventions, promoting well-being and cognitive development in individuals with attention deficits.

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